CLAIMS

1. A refractory metal plate having a thickness, a center, and an edge comprising a uniform texture through said thickness from said center to said edge.

2. The refractory metal plate as defined in claim 1, wherein said uniform texture is substantially an constant mix of {100} and {111} crystallographic orientations.

3. The refractory metal plate as defined in claim 1, further comprising an average grain size of less than 40 microns.

4. The refractory metal plate as defined in claim 1 comprising at least 99.99% tantalum.

5. The refractory metal plate as defined in claim 1 comprising at least 99.999% tantalum.

6. The refractory metal plate as defined in claim 1 comprising at least 99.99% niobium.

7. The refractory metal plate as defined in claim 1 comprising at least 99.999% niobium.

8. A method of making a sputtering target comprising the steps of:
a) providing an ingot with a length-to-diameter ratio up to 3;
b) cold forging the ingot with reductions and elongations sufficient for desired fine grain and texture;
c) subjecting the cold forged product to cross-rolling; and
d) manufacturing the cross-rolled product into a sputtering target.

9. A method for producing a refractory metal plate comprising at least four reducing operations and at least three anneal heat treat operations at temperatures above recrystallization temperature.

10. The method for producing a refractory metal plate as defined in claim 9, further comprising the step of providing a refractory metal starting piece of at least 99.99% purity.

11. The method for producing a refractory metal plate as defined in claim 9, wherein each of the at least three anneal heat treat temperatures are at least 875°C.

12. A method for controlling texture of sputtering targets by a process according to claim 9 wherein the step of reducing operations are performed by changing the number of forging passes and billet orientation between successive forging passes in a manner to produce a desired final texture strength and orientation.

13. A method for producing a refractory metal plate comprising the steps of:
(a) providing a refractory metal starting piece of at least 99.99% purity;
(b) first reducing the length of the refractory metal starting piece to form a first workpiece;
(c) annealing the first workpiece in a vacuum or inert gas to a first temperature of at least 1370°C;
(d) second reducing a diameter of the first workpiece to a diameter substantially the same as a diameter of the refractory metal starting piece to form a second workpiece;
(e) annealing the second workpiece in a vacuum or inert gas to a second temperature of at least 875°C;
(f) repeating steps (b)-(e) as necessary to achieve desired grain structure and texture uniformity;

(g) third reducing the second workpiece to a first thickness to form a first plate;
(h) fourth reducing the first thickness of the first plate to a second thickness to form a second plate; and
(i) annealing the second plate in a vacuum or inert gas to a second temperature of at least 875°C.

14. The method for producing a refractory metal plate as defined in claim 13, wherein the first reducing step comprises reducing the length of the refractory metal starting piece by at least 35%.

15. The method for producing a refractory metal plate as defined in claim 13, wherein the second reducing step comprises reducing the diameter of the first workpiece to a diameter ranging 80% to 120% of the diameter of the refractory metal starting piece.

16. The method for producing a refractory metal plate as defined in claim 13, wherein the third reducing step comprises reducing the second workpiece to a first thickness of at least 4".

17. The method for producing a refractory metal plate as defined in claim 13, wherein the fourth reducing step comprises reducing the first thickness of the first plate to a second thickness up to 1.00".

18. The method of claim 13 wherein the refractory metal starting piece is selected from the group consisting of tantalum, niobium, and alloys of the metals with each other and/or other metals.

19. A process for producing a metal article with fine metallurgical structure and uniform texture comprising:
a. providing a metal billet;
b. forging the billet to a desired billet thickness with about 35% to 50% reduction;

c. recrystallization annealing the billet;
d. bringing the forged billet to about room temperature;
e. side forging the billet a length substantially the same length of the metal billet;
f. recrystallization annealing the billet;
g. bringing the forged billet to about room temperature;
h. rolling the billet to plate with a reduction in thickness per rolling pass sufficient to provide near uniform strain distribution; and
i. recrystallization annealing the plate.

20. A process according to claim 19 wherein the billet is forged at a temperature below the minimum temperature of recrystallization.

21. A process according to claim 19 wherein the billet is forged in two or more forging steps with successive decrease and increase in billet diameter followed by applying an annealing heat treat after each forging step.

22. A process according to claim 19 wherein the metal billet comprises tantalum, niobium and their alloys of at least 99.99% purity.

23. A sputtering target as made according to the process of claim 19.

24. A sputtering target made by a process including forging, rolling and annealing having a target surface comprising:
a) grain size less than about 40 microns; and
b) substantially uniform structure and texture at any location.

25. A sputtering target according to claim 24 comprising tantalum, niobium and their alloys of at least 99.99% purity.